

AMBIENT FINE PARTICULATE MATTER (PM_{2.5}) SAMPLING AND ANALYSIS IN THE UPPER OHIO RIVER VALLEY

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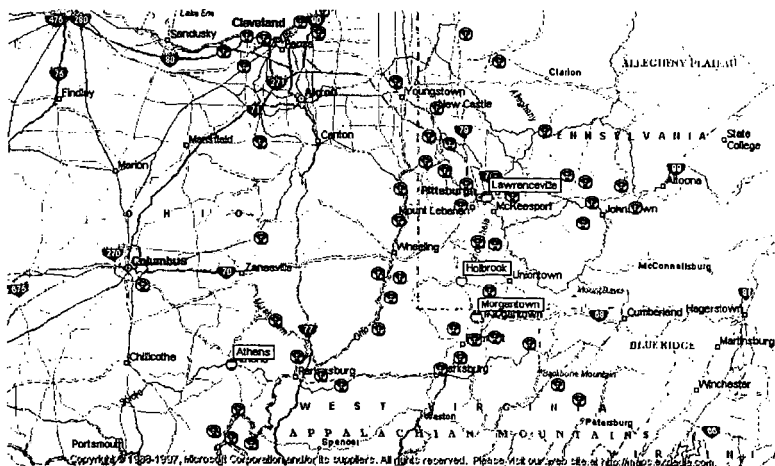
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INTRODUCTION

Ambient fine particulate matter (PM_{2.5}) originates from a wide variety of emission sources, both man-made and natural. The combustion of coal to generate electricity can produce primary PM_{2.5} (e.g., fly ash, carbon soot, associated trace metals), the gaseous precursors (e.g., SO₂ and NO_x) to the formation of secondary fine particles (e.g., ammonium sulfates and nitrates), and condensable species (e.g., H₂SO₄). However, there remain numerous uncertainties regarding the linkage between coal-fired boiler emissions and the visibility and health-related impacts that have been associated with ambient fine particulates. As part of its ambient fine particulate program, the DOE-Federal Energy Technology Center (DOE-FETC), in cooperation with key stakeholders including EPA, local and state environmental agencies, industry, and academia, established and is operating several PM_{2.5} speciation sites in the Upper Ohio River Valley (UORV).

The overall goal of the Upper Ohio River Valley Project (UORVP), is to investigate the nature and composition of fine particulate (PM_{2.5}) and its precursor gases in the Upper Ohio River Valley and provide a better understanding of the relationship between coal-based power system emissions and ambient air quality in the Upper Ohio River Valley region. This geographical area, encompassing southeastern Ohio, western Pennsylvania, and northwestern West Virginia was chosen for this extensive fine particulate research because it mirrors an area in the eastern half of the continental United States that is not well characterized but has a high density of coal-fired electric utility, heavy industry (e.g., coke and steel making), light industry, and transportation emission sources. The UORV is also in the center of the ozone transport region, which provides a platform to study interstate pollution transport issues. This region, with its unique topography (hills and river valleys) as well as a good mix of urban and rural areas, has a high population of the elderly who are susceptible to health impacts of fine particulate as well as other related environmental issues (e.g., acid rain, Hg deposition, ozone).

Advanced Technology Systems, Inc. (ATS), with Desert Research Institute (DRI) as the subcontractor, was contracted by DOE-FETC in September 1998 to manage the UORVP. The map below shows the location of the sites.



Two urban and two rural monitoring sites are included in the UORVP. The four sites selected were all part of existing local and/or state air quality programs. One urban site is located in the Lawrenceville section of Pittsburgh, Pennsylvania. This site is an air quality monitoring station operated by the Allegheny County Health Department. A second urban site is collocated at a West Virginia Division of Environmental Protection (WVDEP) monitoring station at the Morgantown, West Virginia, Airport. One rural site is collocated with the Pennsylvania Department of Environmental Protection (PADEP) at a former NARSTO-Northeast site near Holbrook, Greene County, Pennsylvania. The other rural site is collocated at a site operated by the Ohio Environmental Protection Agency (OEPA) and managed by the Ohio State Forestry Division in Gifford State Forest near Athens, Ohio.

EXPERIMENTAL

Testing and Analysis Plan

Table 1 provides the overall PM_{2.5} sampling and analysis plan requirements.

The UORVP is arranged to obtain a base level of intermittent samples every sixth day at all the four sites. This will allow for estimates of monthly, seasonal, and annual averages. To investigate the differences between months of high production of secondary particulates from atmospheric reactions, one month in the summer will be used for sampling every day, with PM_{2.5} material obtained on a 6-hour schedule to evaluate episodal and diurnal variations in sample composition. Sampling for particulate (ammonium) nitrate and gaseous nitrogen species, as well as ammonia, will provide data to investigate the apparent low nitrate levels found in eastern PM_{2.5} catches.

For comparison with summer conditions, a one-month daily sampling period was performed in February 1999 and another is projected for mid-winter 2000. To provide for comparability with stations to be set up as part of the national PM_{2.5} monitoring network, the basic sampling is being conducted using PM_{2.5} FRM sequential filter-based samplers. In addition, PM₁₀ sequential samplers were installed at one urban and one rural site. The UORVP sampling protocol will allow for a comparison of the PM₁₀ and PM_{2.5} mass and chemistry, but the emphasis of the project is on the PM_{2.5} component.

The measurement of several gases that are relevant to characterizing photochemistry, or are precursors for particle formation, was also implemented. These include ozone and its precursors (NO_x, HNO₃, and NH₃) as well as sulfur dioxide (SO₂). The observations will be completed with the acquisition of surface meteorological data at all sites, including wind speed and direction, temperature, relative humidity, precipitation, and UV radiation and insolation.

ATS contracted DRI and LabCor to analyze the collected samples following the guidance presented in Table 1.

RESULTS AND DISCUSSION

For brevity reasons, only a sample of the results obtained during the month of June 1999 are shown in Table 2. The continuous trace depicts thirty-minute average ambient air particulate loadings obtained with a PM_{2.5} tapered element oscillating microbalance (TEOM) with measurement initiating after midnight of May 31. Besides showing emission trends that peak around midday, the data shows that although the average loading is around 10 to 20 µg/scm, levels as high as 75 µg/scm are evident. The bars shown at intervals represent 24-hour averages for the TEOM (bottom bar) compared to discrete filter 24-hour integrated mass loadings (top bar). Please note that when the values agree closely, the bars are fused into one as indicated by the average values from June 29. These data provide a snapshot of how well the TEOMs and the discrete filter samplers are performing.

CONCLUSIONS

The goal of this project is to obtain and document reliable and quality data pertaining to ambient fine particulate along the Upper Ohio River Valley. The data obtained should:

- Provide generalized idea of types of PM_{2.5} sources.
- Provide input on the impact of sampling artifacts such as condensation/volatilization on FRM performance.
- Provide various correlations (day/night, urban/rural, etc).

- Provide information on PM_{2.5} concentrations/compositions for a part of the country not previously characterized.
- Provide a data base for others to use for:
 - Health studies
 - Source/Receptor analysis
 - Management System Development and
- Provide a platform for further scientific research.

The sample data discussed above confirms that reliable data that can be duplicated by two different sampling techniques is being obtained. Further data reduction, analysis, correlation and interpretation are on going and will be presented at the conference.

ACKNOWLEDGEMENTS

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Table 1 - PM_{2.5} SAMPLING AND ANALYSIS

SAMPLER	DENDRIDER	CHANNEL NO.	FILTER MATERIALS		ANALYSIS	
			Front	Back	Front	Back
SPS-PM2.5	(none)	A	Teflon ^a	Quartz	Mass (Gravimetry), Elements (XRF)	Carbon (TOR)
		B	Quartz	Cellulose/NaCl	Carbon (TOR); Cl, NO ₃ , SO ₄ ²⁻ (IC); NH ₄ ⁺ (AQ); Na ⁺ , K ⁺ (AA)	NO ₃ (IQ)
SASS # 72	(none)	A	Teflon ^a	Quartz	Mass (Gravimetry), Elements (XRF)	Carbon (TOR)
		B	Quartz	Cellulose/NaCl	Carbon (TOR); Cl, NO ₃ , SO ₄ ²⁻ (IC); NH ₄ ⁺ (AQ); Na ⁺ , K ⁺ (AA)	NO ₃ (IQ)
SPS-PM10	(none)	A	Teflon ^a	Quartz	Mass (Gravimetry), Elements (XRF)	Carbon (TOR)
		B	Quartz	Cellulose/NaCl	Carbon (TOR); Cl, NO ₃ , SO ₄ ²⁻ (IC); NH ₄ ⁺ (AQ); Na ⁺ , K ⁺ (AA)	NO ₃ (IQ)
SGS-TP	Nitric Acid	A	Quartz	Cellulose/NaCl	NO ₃ (IQ)	NO ₃ (IQ)
		B	Quartz	Cellulose/NaCl	NO ₃ (IQ)	NO ₃ (IQ)
SASS # 74	Nitric Acid	A	Quartz	Cellulose/NaCl	NO ₃ (IQ)	NO ₃ (IQ)
		B	Quartz	Cellulose/NaCl	NO ₃ (IQ)	NO ₃ (IQ)
SGS-PM2.5	Ammonia	A	Quartz	Cellulose/Citric Acid	NH ₄ ⁺ (AQ)	NH ₄ ⁺ (AQ)
		B	Quartz	Cellulose/Citric Acid	NH ₄ ⁺ (AQ)	NH ₄ ⁺ (AQ)
SASS # 75	Ammonia	A	Quartz	Cellulose/Citric Acid	NH ₄ ⁺ (AQ)	NH ₄ ⁺ (AQ)
		B	Quartz	Cellulose/Citric Acid	NH ₄ ⁺ (AQ)	NH ₄ ⁺ (AQ)
FRM (R&EP) ^a	(none)	-	Teflon ^a	(none)	Mass (Gravimetry), Elements (XRF)	-
FRM (R&EP) ^b	(none)	-	Quartz	(none)	Carbon (TOR); Cl, NO ₃ , SO ₄ ²⁻ (IC); NH ₄ ⁺ (AQ); Na ⁺ , K ⁺ (AA)	-
Portable PM2.5	(none)	-	Polycarbonate	(none)	COSEM	-

XRF = X-Ray Fluorescence, TOR = Thermal/Optical Reflectance, IC = Ion Chromatography, AC = Automated Colorimetry, AA = Atomic Absorption, COSEM = Computer Controlled Scanning Electron Microscopy

TABLE 2: Lawrenceville-TEOM PM2.5 & SFS PM2.5

